# Mechelециv

VOL. 16 NO. 4

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SCHOOL OF ENGINEERING
THE GEORGE WASHINGTON UNIVERSITY

MARCH 1957

**Robert Lautzenhiser, class of '49, speaks from experience when he says:**

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Following his graduation with a B.S. degree in Metallurgical Engineering, Robert Lautzenhiser joined U. S. Steel as a Junior Metallurgist at the Waukegan Works of the American Steel & Wire Division. Here, he became familiar with the many types of wire and wire products produced, through the practical performance of various physical tests in the metallurgical laboratory.

The knowledge Mr. Lautzenhiser gained of the characteristics of stainless steel wires led to his advancement, in April, 1950, to Product Metallurgist. In this capacity, his duties were of the customer-contact nature. His responsibilities in this work included consultation and the advising of customers regarding the proper steels for their projects.

Mr. Lautzenhiser received his appointment as Product Metallurgist for stainless steel wire in April, 1954. His work on this relatively new product, in which he developed exceptional skills and abilities, resulted in his advancement to Division Metallurgist in July, 1955.

Mr. Lautzenhiser feels that the graduate engineer gains much from the well-planned and complete training program at U. S. Steel. "Furthermore," he says, "the friendly atmosphere and unusually cooperative personal relationships throughout the company are a big help in acquiring the knowledge that leads to advancement and success in one's chosen field."

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# The Mecheleciv

VOL. 16 MARCH 1957 NO. 4

SCHOOL OF ENGINEERING, THE GEORGE WASHINGTON UNIVERSITY

## IN THIS ISSUE



## DEPARTMENTS



## ON OUR COVER

MOBILE RADAR EQUIPMENT IN ACTION
—U.S. ARMY PHOTOGRAPH

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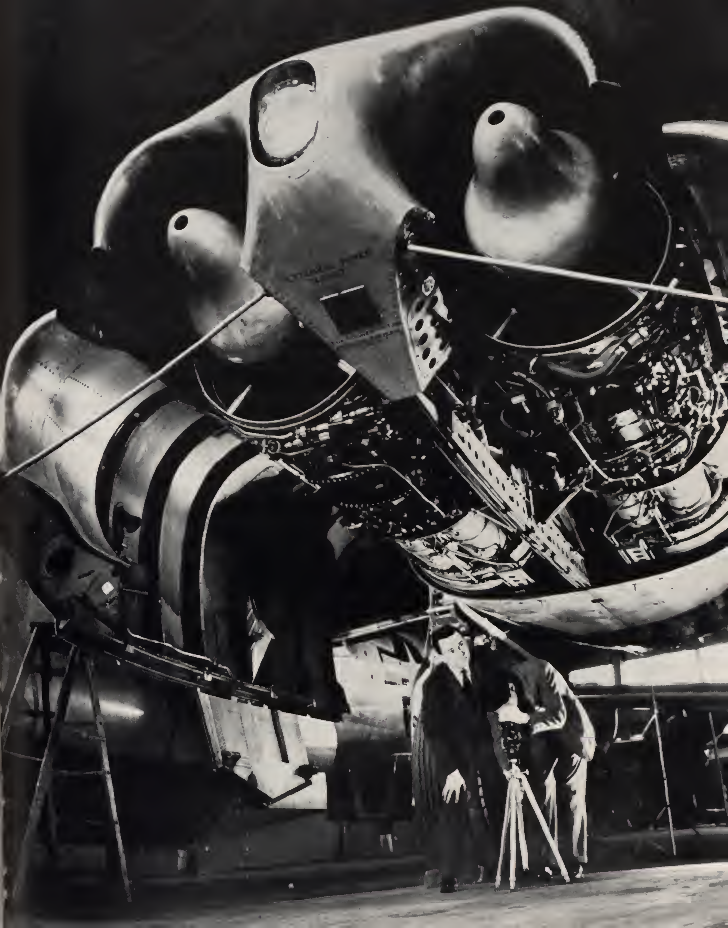
## FRONTISPIECE

### POWER ON THE HALF SHELL

*These dual-mounted J-47 jet engines represent the massive power required in the modern B-45 supersonic bombers. The Air Force hopes the power represented by this front view of the craft will be sufficient to prevent any enemy plane from seeing more than a vanishing view of the rear.*

CUT COURTESY OF G. E.



# FACULTY PAGE

# ENGINEERING STUDY IN THE NATION'S CAPITAL

*By* **Dr. Paul A. Crafton**
***Professor of Mechanical Engineering***

There are many advantages within the reach of those men and women who pursue their studies in a geographical area in which their fields of study are practiced. It would seem almost obvious that the student of public law or of political science would best prepare for his future calling or extend his preparation for his present profession at this seat of government where public law and political science are indeed the very purpose of the District of Columbia as the Federal enclave. The advantages for the engineering student in the Washington area are probably not as obvious, but are nonetheless as numerous and useful.

In the light of the modern trend to emphasize engineering science in formal professional education, this School of Engineering in the capital city finds itself in an enviable location. We are in the geographical midst of a complex of outstanding engineering research and development laboratories, a concentration of quality and quantity that is unique in our country. Their proximity provides an atmosphere of engineering practice that is of great value to the student. In addition, students who want part-time employment during term-time, full-time employment during the summer recess, or full-time employment the year, 'round find interesting and related work in these many engineering organizations. Not only do we have the governmental laboratories but also many private companies as well; their establishment in Washington has been due to the professional engineering atmosphere that for many years has pervaded this city.

The library resources of our University are supplemented by the superb collections in the fields of engineering of the Library of Congress. In this regard, the student here has library facilities at his disposal that are superior to those of the Engineering Societies Library in New York City. The upper-class student finds that the many library collections are only in addition to the wealth of engineering information locally available from the agencies of the Federal Government. For example, to what better place would one go in order to obtain the very latest library information on aircraft flutter than the headquarters of the National Advisory Committee for Aeronautics?

Our professional neighbors are not limited to the purely engineering organizations. They also include the large number of other governmental and private agencies employing engineering talent. In these and others, engineers are concerned with the administration of programs of great importance, involving large sums of money. The graduate program in engineering administration of the School of Engineering, situated in this sea of engineering administration, offers the student unique opportunities for study in this field. The nation's capital is as pre-eminent in engineering administration as it is in engineering science.

It therefore behooves the engineering student at our University to realize and to utilize the many resources of the nation's capital in the pursuit of his undergraduate or graduate studies. In no other community are they as outstanding as in ours.

# MECHANICAL ENGINEERS IN ELECTRONIC DESIGN

*by Phil Payne*
*B.M.E. '58*

Mechanical engineering in electronic design has become of increasing importance with the growth of the electronics industry. With the introduction during World War II of radar, sonar, aviation equipment, and other wartime equipment the electrical engineer found that he could not handle the design job alone. Thus, the electro-mechanical design team evolved. Advances in the electronic field carried over into peacetime causing further need for this electro-mechanical team in such fields as television, sound recordings, commercial aids to navigation, and electronic computers.

The purpose of this article is to clarify the role of the mechanical engineer in electronic design. A typical design problem will be discussed, and problems which the mechanical engineer will encounter in various fields of electronics will be pointed out.

## MECHANICAL DESIGN OF A RADAR PEDESTAL

Problems involved in a radar pedestal design cover most of the mechanical engineering education before the design is complete. Environmental conditions such as temperature, humidity, windload, and altitude must be integrated with the over-all systems requirements. Gear trains must be designed to give accuracy in elevation, azimuth, and slewing speeds. Other factors which must be considered are choice of material, manufacturing tolerances, backlash in the gear trains, and torque requirements for varying wind loads.

The mechanical engineer is responsible for the design and manufacture of the antenna structure. This calls for a knowledge of microwave techniques to meet specifications of extremely narrow beam widths. Here a large structure of light weight and low-inertia must be designed within extremely precise tolerances. Parabolic reflector design requires skill in optics.

The structural design of the base and the antenna mount, which frequently necessitate the use of rigid, lightweight castings, is also the responsibility of the mechanical engineer. Care must be taken in method of construction, choice of materials, and selection of the proper finish to protect the structure under widely varying weather conditions.

The mechanical engineer and the electrical engineer together must solve the problem of designing slip rings to provide connection for the various electrical signal and power circuits through the rotating mount.

Within the pedestal, the precision equipment and electronic gear must be housed. Provisions are required for the dissipation of the heat generated by this internal equipment. The inaccessibility of many of the moving parts make care in design of the parts and selection of lubricants a must to insure operation under tactical conditions, which sometimes prohibit frequent maintenance. Often, both heating and cooling facilities must be put in the housing to maintain performance in either arctic or tropic environments.

Severe shock conditions are imposed on the design by the high-speed rotation and quick reversal of the mount. A further complication is that the antenna pedestal, which may weigh several tons, may be destined for ship board installation where pitch, roll, and gun blast impose further condition of shock and vibration.

Project responsibility lies with the mechanical engineer due to the obvious mechanical complexity of an antenna-pedestal. In addition to usual estimating, scheduling and cost control, and design responsibility required of a project engineer, the mechanical engineer is also frequently responsible for a major subcontract for design and fabrication of such a pedestal.

## *AIRBORNE EQUIPMENT*

The design of airborne electronic equipment requires many of the considerations given the ground antenna mount. However, many other conditions must be taken into account. For example, weight will have to be kept to a minimum and different conditions of shock are encountered. Units must be hermetically sealed and air-conditioned to protect against varying temperature, humidity, and pressure. Remote controls for isolated equipment will be required. While solving these problems, the mechanical engineer must also design for ease of maintenance and repair.

## *TUBE DESIGN*

Electron tube development and design present the mechanical engineer with another variety of problems. Ultra high-frequency power tube design requires a knowledge of evacuating techniques, heat dissipation methods, and metal-to-glass seal characteristics. In the design of anode and cathode structures, the mechanical engineer and electrical engineer must work hand-in-hand. The shape of the anode must not only provide structural strength, and rigidity, it must also allow for good heat dissipation and in some cases, establish the operating frequency by acting as a resonant cavity. All the internal parts of a tube must be vibration resistant and constructed to prevent mechanical resonances.

Within the region of the mechanical engineer's job in electronics is the design and development of machinery to make tubes and tube parts. These machines assemble, evacuate, and seal electron tubes automatically. In order to accomplish these designs, the mechanical engineer must call upon his knowledge of kinematics, mechanisms, and machine design.

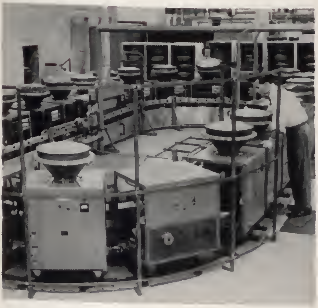
### *TELECASTING EQUIPMENT*

Technical design problems faced by the mechanical engineer in telecasting equipment design are numerous and varied. Among these problems has been the synchronization of film speeds established by the movie industry and scanning speeds of television. Quick stop and start of movie films in televising has also required mechanical engineering skill in design.

In the design of television cameras, it is essential that the heavy camera be moved rapidly without effort. The camera package must be designed for ease of maintenance and good heat dissipation. This requires a quiet cooling system to prevent noise during broadcasting. The package must also be small, yet house a relatively large image tube on vibration-free mountings.

### *MECHANICAL DESIGN OF RECEIVERS*

In the design of the home receiver, the mechanical engineer works in close coordination with the electrical engineer and the styling designer. Here the goal is a finished product which combines beauty with quality and utility. The design of television receivers, FM and AM radios, and record players offers the mechanical engineer problems in heat dissipation, serviceability, vibration, component mounting, and protection of the consumer from electrical shock. All these problems must be solved within the limits s t by the stylist, to appeal to the public. High quality production of home-consumer goods requires close contact with vendors and close production follow-up. The problem of giving the public a more efficient product in a smaller package at less expense demands great skill and imagination of the mechanical engineer.



**Engineer inspects assembly line for the automatic manufacture of T-V picture tubes.**

**Mobile radar equipment typifying the many applications of mechanical engineering to electronic gear.**

### *MINIATURIZATION AND NEW PRODUCT DESIGN*

Miniaturization, subminaturization, and simplification are a few of the new developments toward smaller, more efficient units in which the mechanical engineer participates in large measure. The transistor and printed circuit have opened a whole new field of endeavor. For example, the transistor makes it possible to house a hearing aid in the arm of a pair of spectacles. Consider the problems the mechanical engineer encounters in miniaturizing the components in such an amplifier and putting the parts into the arm of the glasses.

### *AUTOMATION*

The development of the printed circuit coupled with subminiaturization quite naturally leads to automation. Both are ideally suited to automatic production. The mechanical engineer has already solved the problems of printing, etching, plating and dip soldering printed circuits. Now, he must create machinery which will produce equipment complete from raw material to finished product. Automatic machines for printing the wiring, shearing the boards to size, punching component insertion holes, inserting components, soldering and testing the finished board must be designed. In the area of automation the responsibility lies with the mechanical engineer.

### *CONCLUSION*

The electrical engineer cannot be expected to solve problems in heat transfer, humidity, shock and vibration, precision instrument gearing and power drives, structural design, production economics, and mass production techniques and also develop and design circuits. The fundamental background of the mechanical engineer's education prepares him to solve these problems. Thus, the role of the mechanical engineer in electronic design is of great importance and continues to grow in importance with the expansion of the electronics industry.

# SUPERCHARGING

***BIGGER BICEPS FOR THE RECIPROCATING ENGINE***

***Orron Kee***
***B.M.E. '57***

This year there is a minor revival of interest in automobile supercharging taking place in this country. While this attention is still of small proportions, it may be well worth while to examine the potentialities of supercharging, the characteristics of the major types of superchargers, and the future prospects of supercharging as applied to automobiles.

To begin with, a supercharger is a device for compressing the air or fuel-air mixture of an internal combustion engine before the air or mixture enters the combustion chamber, instead of relying entirely on the pumping action of the engine's pistons. Superchargers are practically as old as the automobile itself. As early as 1896, Rudolph Diesel obtained a patent for a supercharger for a compression-ignition (Diesel) engine. The first use of a supercharger on a gasoline automobile engine occurred in 1907 when the Chadwick Company found that supercharging would help the performance of their new six-cylinder car by improving the induction through the undersized intake valves. After the Chadwick, little was done with supercharging until World War I when it was developed for use on high-altitude aircraft. Following the war automobile superchargers were revived in sports cars largely because racing formulas limited the displacement of engines but placed no restrictions on the use of superchargers. Although the formulas were later changed, practically every major European race was won by supercharged cars until after World War II. The value of supercharging is indicated by the 1938 racing rules which limited engine displacement to 183 cubic inches supercharged and 275 cubic inches unsupercharged.

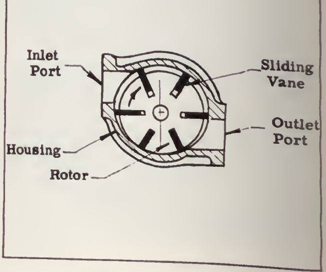
Aside from racing, ordinary production cars built between the World Wars were also equipped with superchargers. In Europe, Mercedes, Alfa-Romeo, and MG offered superchargers, and several of the smaller American companies, such as Graham, Cord, Stutz, Dusenberg, and Auburn, marketed supercharged models. Since World War II, however, only a few automobiles have had superchargers as standard equipment, although they may be purchased as accessories. The present situation seems somewhat regrettable when the benefits of supercharging are considered.

All superchargers have certain advantages to offer and some draw-backs when used on automobile engines. The desirability of superchargers stems mainly from the fact that supercharging increases the density of the fuel-air mixture in the cylinder. With a higher density charge, more energy is liberated during combustion and the gross horsepower developed by the engine is increased. Since the power required to drive the supercharger is usually much less than the increased horsepower developed, the net horsepower of the engine is increased. By the same reasoning the torque is also increased.

For any given horsepower requirement, the supercharged engine does not have to run as fast as the same size engine without a supercharger, so the engine wear is reduced on the supercharged engine. Because the weight of a supercharger is low, the increased power of the engine is achieved with little increase in weight, and thus the weight of a supercharged engine per horsepower or torque output is less than the weight of an unsupercharged engine for the same output.

An incidental benefit of supercharging is the creation of turbulence when the air or mixture passes through the supercharger. This turbulence results in better mixing of the fuel with air and hence a better balanced distribution of mixture to all cylinders, a more uniform burning rate during combustion, and easier starting of the engine.

As has been suggested, the result of supercharging is an increase in the volumetric efficiency of the engine. This increase is particularly useful at the higher engine




Vane Supercharger

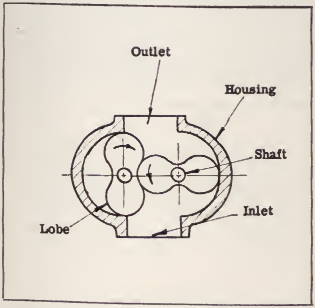
speeds where the volumetric efficency of the ordinary engine decreases due to throttling through the manifolds and valves. In most cases the brake horsepower of the supercharged engine is increased by more than the amount that the friction horsepower is increased by the presence of the supercharger. Hence, the mechanical efficiency of the engine is increased by supercharging.

The increase in volumetric and mechanical efficiencies with supercharging would seem to indicate that the fuel consumption of an engine would be lowered by supercharging. However, if the engine is already operating at the highest compression ratio allowable with the available fuel, the compression ratio must be lowered in order to prevent preignition when the engine is supercharged. (This is because the fuel-air mixture can be compressed to higher pressures in a supercharged engine since it is effectively compressed in two stages by the supercharger and by the engine's piston.) Lowering the compression ratio reduces the thermal efficiency of the engine, and consequently the fuel consumption of the engine increases for this case.

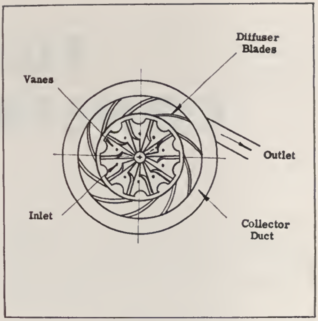
When using a supercharger, care must be taken that the pressures and temperatures attained in the combustion chamber are not too great. The pressures must not overstress the engine structure, and the temperatures should not overtax the cooling system. Therefore, preignition, the engine structure, and the cooling capacity are the factors limiting the supercharging pressure boost on a given engine.

Superchargers may be expected to increase the horsepower and torque of an engine, reduce the engine weight per horsepower and the engine speed per horsepower, and improve the mixing of fuel and air, but these advantages may require modifications of the engine which will result in some increase in fuel consumption. The characteristics of the various types of superchargers may be seen more clearly by an examination of the individual classes of superchargers.

Supercharging may be accomplished without a compressor by utilizing the ramming effect of the moving vehicle on the air. Unfortunately this effect is negligible at speeds under 100 miles per hour; and, therefore, other means must be used for supercharging automobile engines. Supercharging compressors may be classified as either positive displacement or dynamic machines.




**Roots Supercharger**




**Centrifugal Supercharger**

The positive displacement class includes reciprocating piston compressors, vane compressors, and Roots or lobe-type blowers. However, the piston type compressors are seldom used on automobiles, although they are installed on large stationary internal combustion engines.

The dynamic superchargers are either centrifugal or axial machines. Owing to its low pressure rise, the axial compressor is rarely used on automobiles and is generally used only in stages on aircraft. Thus the superchargers suitable for automobile use are restricted to centrifugal, Roots, and vane compressors and variations of these types. These three superchargers have many individual differences which affect their suitability for automobile usage. Therefore, each supercharger will be discussed separately in order to evaluate its characteristics.

The centrifugal supercharger is the type which has been used almost without exception on American supercharged production and racing cars. It consists of a rotating disk with impeller blades surrounded by a fixed housing which usually contains diffuser blades. The air or mixture enters the supercharger at the hub and is spun radially to the outside of the housing by the impeller. The centrifugal action adds kinetic energy to the fluid, and then this energy is converted to flow energy by the diffuser blades and the housing which reduce the velocity of the fluid, thereby increasing its static pressure.

The conversion of kinetic energy to pressure is actually the major disadvantage of using the centrifugal supercharger on automobiles. The kinetic energy and, consequently, the pressure rise in the fluid vary with the square of the rotational speed of the impeller. When the supercharger is driven at a speed proportional to the engine speed, the pressure drops rapidly as the engine speed is reduced, leaving very little supercharging effect

*(Please turn to page 32)*

# TILT-UP CONSTRUCTION

*by Dick Rumke*
*B. C. E. '57*

Every contractor is looking for a new way to save time and money. Thanks, both to labor and material shortages together with accelerated construction schedules during the war, a swift and economical method of building individually designed reinforced concrete structures by casting the walls on a horizontal base and then tilting them into position has gained impetus. The method of construction is aptly termed "tilt-up."

Figures obtained from the Portland Cement Association indicate that ninety percent of the form work can be eliminated, since only edge forms are required. The *Journal of the American Concrete Institute* (May 1948) reports thirty percent labor savings over walls with conventional forms. Estimates in the January 10, 1952 issue of *Engineering News-Record* compare tilt-up

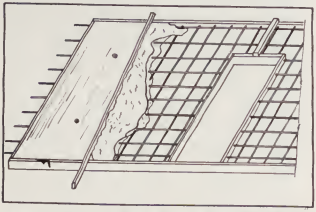


***Figure 1*—Partial wall panel section showing reinforcement, door frame, panel lifting bolts and dowel extensions.**

construction time as being twenty-five to forty percent of that required for a comparable brick wall.

Contractors and architects alike are recognizing the potentialities of tilt-up construction because of the variety of architectural effects and exterior surface treatments that can be obtained. Because the walls are poured in a horizontal position, tooling, grooving, or the placing of stones in the fresh concrete is made easier. These features together with the desirable qualities of concrete such as fire safety, durability, and low maintenance cost brighten the future of tilt-up construction even more.

The wall panels are designed to withstand bending stresses caused by the tilting procedure. That is, the dead weight of the panel itself acts as a uniform load applied between the pick-up or lifting points of the panel.

The wall panels may vary in width, heighth and thickness as circumstances warrant. As an illustration, tilt-up walls used to enclose a defense plant at Pomona, California for Consolidated Vultee Aircraft Corporation were four and five-eighths inches thick, twenty feet wide and twenty-six feet high, whereas wall panels for the Ford Motor Company in Detroit, Michigan, were eight inches thick, twenty feet wide and ten feet seven inches to fourteen feet one and a quarter inches high.

In general, there are two methods of treatment for tilt-up walls — the conventional air cure treatment and the vacuum treatment. The air cure treatment will be considered first.

Whenever practical, the floor slab is poured first and then given a steel trowel finish in order to obtain a dense, even surface. The floor or base slab is then used as a casting bed for the walls. Where space is at a premium, a casting bed can be set up away from the site. Assuming that the floor slab is being used, a bond-breaking compound is spread over the slab in order to prevent the wall panel from adhering to the slab.

Edge forms for the panels are then laid on the slab and positioned as close to the up-right location of the wall panel as possible. These edge forms can be made of either wood or steel shapes depending upon the number of times they are to be used. Door and window frames are set in place together with the electrical conduit and outlet boxes. Finally, the reinforcing steel is positioned, followed by the placement of lifting inserts.

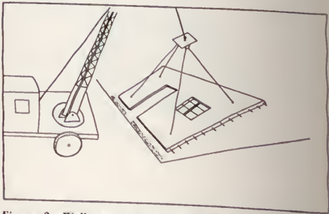


***Figure 2*—Wall panel being tilted into position and set into a bed of mortar using a four-point pick up.**

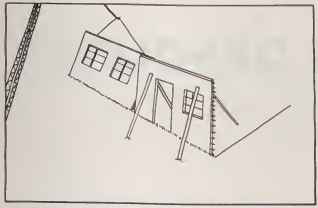


***Figure 3***—**A wall temporarily braced into position while a second is tilted onto the mortar bed.**

It is important that the lifting inserts be placed according to plan and not indiscriminately in order to avoid stress concentrations in portions of the panel while the wall is being tilted.

The entire panel is then poured. screeded level. floated and finished with the necessary architectural treatment required. Figure 1 gives the general scheme of the above steps.

After the wall slab has been cured and attained approximately sixty to seventy percent of its strength, the forms are removed. Cables are attached to the lifting inserts and then, by means of a lifting rig, the panel is tilted onto a bed of mortar and in a vertical position. See Figure 2 showing a four-point pick-up and mobile crane.

After the wall has been set vertical, it is temporarily braced, as shown in Figure 3, and the excess motar is struck. After all the panels have been plumbed, lined and braced, cast-in-place columns are poured between each panel as shown in Figure 4. A slightly different arrangement of tying the wall panels to the columns is used if the building has a steel frame. The defense plant at Pomona, for example, is of this type and the contractor placed two steel plates near the edge of each wall. After the panel was tilted, stud bolts were welded to the plates and additional plates were then welded to the column and bolted to the wall panel. The latter procedure is shown in Figure 5.

Mr. K. P. Billner and Mr. Bert M. Thorud, in their article "Vacuum Processes applied to Precast Concrete Houses" appearing in the October 1949 *Journal of the American Concrete Institute*, describe the specific vacuum methods utilized as "(1) extracting excess water from freshly placed concrete prior to set, thereby increasing early strength and enabling early handling of units, (2) holding forms in place by vacuum, and (3) handling and placing finished and hardened concrete units by cast-in-place closures formed and quickly hardened by vacuum processes."

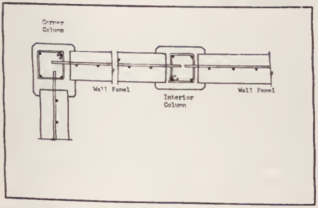



***Figure 4***—**General plan showing how cast-in-place interior and corner column bond the panels into a structural unit.**

The vacuum process utilizes an engine-driven pump and special-lined mats which are connected to the pump by means of hose connections. These mats form the frame for the wall. Frames, conduit, reinforcement and concrete are placed as before. Prior to the intial set of the concrete, the engine-driven pump is turned on and causes a vacuum in the mats. The vacuum sets up a suction which extracts the excess water from the freshly poured concrete. By losing water, the concrete has had its water-cement ratio reduced and thus the strength is increased and curing time has decreased.

In place of the inserts required by the air cured method, the vacuum process uses the suction through a special frame that is placed across the panel and then titled into position by means of a hoist. For muitiple unit work, the vacuum process is faster and more economical than the air cure process.

Although most of the work in tilt-up construction has been in the industrial field among warehouses, factories and garages, several contractors have been doing considerable work toward applying tilt-up to residential homes for the low income group. In a multiple housing development, tilt-up construction has proven to be favorable in competition with the standard frame house.

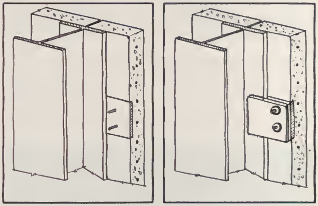


***Figure 5***—**Detail of the connection between the panel and steel columns.**

Depending upon the use to which the wall panels will be applied, the interiors can be furred and plastered for residental work in northern climates and the concrete itself painted where the climate does not require insulation in the house for comfort. A clear coat of waterproofing is applied to all exterior walls to prevent seepage of water.

Tilt-up construction is not limited to one-story construction. It can be and is being extended to multiple stories — the procedure for casting on each floor slab and tilting being the same as for the first floor or basement walls. The future of tilt-up is looking up.

# IS THE BRAIN OBSOLETE?

### *INFORMATION STORAGE DEVICES*

*John Manning*
*B. S. E. '57*

Perhaps the best information storage device is the human brain. The brain is capable of data storage for long periods of time. It needs but a negligible amount of time for reading in and out, and its power requirements are small; however, this ingenious device has its limitations. It occasionally goes blank, becomes frustrated, and appears to have a limited capacity.

Realizing this, a need for mechanical storage devices arose. Probably one of the earliest information storage devices was used by the shepherd. He used marked stones and as the sheep passed into an enclosure for the night, he placed a stone in a box. An examination of the stones disclosed whether any sheep had been lost.

As the art advanced, the abacus was invented and used for calculation and data storage. An abacus is a contrivance consisting of beads or balls strung on wires or rods and set in a frame.

Robinson Crusoe counted the passing days by carving a notch in a palm tree. This was information storage in that he made a record of the number of days he was marooned on the island. Wild Bill Hickok stored information on the handle of his gun by carving a notch for each man he shot. One could say the read-in time here was rather slow.

And so, one can see that information can be stored in countless ways. Some of the more modern devices used for storage are preset switches, punch cards and tapes, neon bulbs, and relays. Neon bulbs can be arranged in circuitry so that when the bulb is conducting, it may represent a binary 1 and when non-conducting, a binary 0. Similarly, a relay can be multi-stable and represent a plurality of conditions depending upon the position of the armature.

**Electronic computer utilizing punched tape, magnetic drum, and magnetic tape memory devices.**

The preceding examples of storage devices store information in either binary or decimal codes. Certain devices store information in other forms, some of which appeal to the senses of hearing or sight. A piano roll, which is a punched paper tape, stores information which can be reproduced when threaded through a player piano. A phonograph record stores a multiplicity of frequencies and, depending upon the quality of the record and the reproducing equipment, it is possible to store and reproduce the entire audio spectrum. The improvement of the quality of phonograph records has become a great challenge to recording companies.

## ECCLES-JORDAN CIRCUIT

The Eccles-Jordan Circuit is a two-stage direct-coupled amplifier in which the output of the second stage is connected to the input of the first stage. The Eccles-Jordan circuit is similar to a multivibrator, except that direct (or d-c) coupling is used instead of resistance-capacitance coupling.

The E-J circuit has two stable conditions. In the first, the first tube carries a large plate current and the second tube no current. In the second, which is similar to the first, the second tube carries the large current, and the first tube no current. These correspond to the conditions that exist in a multivibrator on the alternate half cycles. Unlike the multivibrator, however, these conditions are stable in the E-J circuit, since there is no capacitator being discharged which ultimately changes the operating condition.

The current in the E-J circuit can be switched from one tube to the other by applying a positive pulse to the grid of the nonconducting tube of sufficient amplitude to cause the instantaneous grid potential to be momentarily less than cutoff. Alternatively, one may employ a negative pulse applied to the control grid of the conducting tube and having sufficient amplitude to drive the grid potential of this tube momentarily more negative than cutoff. In either case, the system jumps instantly from one stable state to the other, resulting in what is commonly called a trigger or flip-flop action, which is a bistable characteristic.

Thus it is seen that the E-J circuit can be used as a binary storage device with each of the stable states rep-

resenting a binary digit. If a plurality of circuits are connected in a chain, a plurality of binary orders may be represented.

## MAGNETRON BEAM SWITCHING TUBE

The Magnetron Beam Switching (MBS) tube (*Mechelectiv*, May 1956) establishes a theorem that each position of an electron beam distributor should be capable of forming the electron beam, of switching the beam in a number of ways, of providing a useful pentode-like output, and being able to clear or cut off the electron beam.

The tube consists of ten individual positions mounted radially about a central cathode and operating in the presence of an axial magnetic field. This magnetic field is provided by a small cylindrical magnet permanently attached to the evacuated glass envelope. The electric field is supplied by different potentials applied to the various electrodes. The overall length of the MBS tube is three inches and with the magnet in place, it is slightly over one and one-half inches in diameter. The MBS tube could be described as ten triodes in a single envelope and capable of yielding a pentode-type output.

In order to perform the functions of beam switching, the MBS tube has at each individual position, (of which there are ten,) three basic electrodes of proper impedance characteristics. They are: (1) A SPADE to "automatically form and lock the beam which uses a minimum of power with a high degree of reliability and being substantially independent of frequency. (2) A TARGET OUTPUT PLATE or TARGET with an efficient high current pentode-like output. (3) A SWITCHING GRID, adaptable to all types of inputs, which will switch at high speeds for high speed sequential switching without drawing current.

Thus, it is seen that the MBS tube can be operated as a decimal counter and storage device. Translating circuits are not needed to convert the decimal code to other codes. Also, the tube may be operated in the megacycle range which provides fast switching and storage action. Devices are available which may be used in circuitry with the MBS tube for a visual display of the stored digits.

## MAGNETIC DRUMS & TAPES

By transposing information into electrical pulses and applying these pulses to magnetizable areas of a drum or other member rotatable or movable at high speed, data will be readily accessible for reading or reproduction. By means of various controls, data can be readily applied to any desired portion of a track on the movable members, or any selected item of data in a track can be located and read, altered or erased.

The rotary drum or moving member must be suitably mounted in journalled bearings and driven by a motor. The motor may be geared to the drum shaft so that the drum will be rotated at speeds ranging from 200 to 1500 inches per second. Generally speaking, the speed of rotation of the drum is limited only by the motor speed because no problem of tape adherence to the drum occurs even at the highest speed mentioned. During periods when data are being placed upon or taken from the drum, the motor will continuously rotate the drum.

As an example, the drum may have a diameter of thirty-four inches and be approximately ten and one-half inches wide. The drum is formed of aluminum or other generally non-magnetic material.

The periphery of the drum is covered with magnetic tape, such as, iron oxide coated paper tape. A separate band or track of magnetic tape is adjacent to one end of the drum for use as a timing or synchronizing pattern track. However, the timing track may be formed integrally with the body of the magnetic tape. The binary magnetic spots, that is, spots having flux oriented in one of two possible directions (a north pole or south pole), may be recorded upon and removed from the message or intelligence tracks of the drum. Additional tracks may be employed to locate specific spots or cells in the intelligence tracks as the drum rotates.

Using a drum with the above dimensions, the diameter of the drum is thirty-four inches and each track will have a length circumferentially of the drum of 107 inches. Each track is subdivided into 5,340 cells. Using forty tracks, the entire drum will carry well over 200,000 digital cells. With the motor rotating at such rate that the drum periphery will have a speed of 1,400 inches per second, the magnets can scan the drum at the rate of 70,000 digital cells per second.

A plurality of magnets (forty) is positioned adjacent the periphery of the drum, the magnets being so spaced lengthwise to the drum that each magnet will be opposite a track or band of the drum. In this way, each magnet will scan or record upon a drum track of predetermined width. The magnets are capable of energization by a varying signal current.

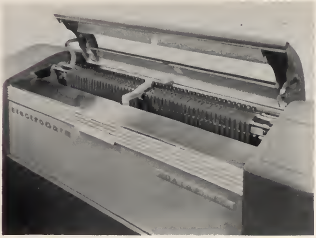
The digital tracks are adapted to receive in each cell a magnetization or element of data representing pattern of varying value, for example, positive or negative. In this way, binary digital signals of a coded system may be used, with one value representing "1" and the other value representing "0". The direction of the current induced in the magnet by the magnetic spot in discrete areas on the drum, determines whether the digit is a "1" or a "0."

Magnetic tapes and magnetic disks can be used in a manner similar to the magnetic drum.

## FERROELECTRICS

A "ferroelectric substance" is defined as one which when exposed to an alternating polarizing voltage exhibits a relationship between electrostatic polarizing

*(Please turn to page 36)*



**Fifty lengths of magnetic tape provide access to unlimited volumes of stored information.**

# REACTORS FOR RESEARCH

*By Howard Davis*
*B. M. E. '57*

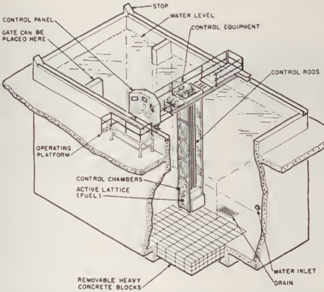
In the progress of a nation one item constantly appears in foreground of those essentials necessary for advancement. That item is energy, and man is continuously on the outlook for new sources of energy to power his industries. In the past and through today, fossil fuels have been, and are, the chief source of energy from which we derive mechanical work. Reserves of fossil fuels are not inexhaustible, however, and we must look for new sources of energy. Some new sources of energy being investigated today include nuclear energy, solar energy, and tidal power. Of the sources under present study, nuclear energy appears to be the most promising. It has been estimated that energies contained in nuclear fuel reserves are 17 times the quanity of energy contained in our reserves of fossil fuels. This large amount of energy reserve available to us explains, somewhat, the intense efforts being made to develop nuclear power devices.

An important device that has been developed to help carry out research and development of nuclear power is the research reactor. A popular model of the research reactor which is being widely adopted in our research centers is the bulk shielding reactor. This reactor, because of its characteristic design, is commonly referred to as the "swimming-pool reactor." In this type of reactor the core is submerged in a large pool of water approximately 20 x 20 x 40 feet in dimension. Ordinary water serves as a moderator, reflector, shield, and coolant.

The heart of any reactor is the fission process. For purposes of discussion the fission process might be compared with the combustion process. In the combustion process fuel is burned and the heat of combustion is transformed into mechanical work. Similarly in the fission process fuel is subjected to fission and the heat of fission is transformed into mechanical work. In the combustion process the chemical change that takes place is due to a redistribution of electrons, whereas in the fission process the chemical change that takes place is due to break-up of the nucleus and redistribution of nuclear particles. Further, many of the products of fission are radioactive and introduce the problem of shielding to protect operating personnel. In the fission of uranium 235, an enriched form of natural uranium, more than 80 primary products are formed having mass numbers ranging from 72 to 160. Each of these products undergoes, on the average, three stages of radioactive decay before transmuting into a stable nucleus. As a result there are over 200 radioactive isotopes of 30 or more elements present within a very short time after fission. In recent years there have been produced by various nuclear reactions, unstable isotopes of all the known elements.

According to present atomic theory the stable atom comprises a small nucleus made of protons and neutrons, and a number of electrons equal to the number of protons, moving about the nucleus in orbits at varying distances from the nucleus. The proton carries a single unit positive charge equal in magnitude to the elementary electron charge. The neutron is electrically neutral and does not experience electrical repulsion when it approaches a positively charged nucleus. It might be thought that a system of closely packed and positively charged protons, such as exists in an atomic nucleus, would fly apart because of electrostatic repulsion existing between like charged particles. Logically one might arrive at such a conclusion. However, evidence is at hand that there is a force that holds protons to protons, and neutrons to protons. Deuterium, the isotope of hydrogen having a mass number 2, consists of a neutron and a proton giving evidence that forces of attraction exist between neutrons and protons. The helium isotope, having mass number 3 and containing 2 protons and 1 neutron, gives evidence of proton to proton forces of attraction. Little is known about the nature of these forces and nuclear stability cannot be satisfactorily explained at this time. We have given the name "binding energy" to these little known forces. It is this energy that is released in the form of heat and manifests itself as the kinetic energy of fission fragments.

In the fission process a nucleus absorbs a neutron and forms an excited compound nucleus. The energy of the absorbed neutron being added to the binding energy of the target nucleus. As a result of this added energy the compound nucleus is said to be in an "excited state" and may be considered to undergo vibration or a series of oscillations. If the excess energy causing these oscillations is insufficient to overcome the binding energy existing between the neutrons and protons and




**Light-water-moderated or "swimming pool" reactor designed for enriched uranium fuels.**

*Cut Courtesy A. E. C.*

thereby cause distortion of the target nucleus, oscillations will subside and the nucleus will return to its original state and expel the excess energy by expulsion of a gamma ray photon.

If the excess energy is sufficiently high, the nucleus assumes a distorted shape which might be visualized as having the form of a dumbell. The energy required to cause such a distortion is called the "critical energy of fission." If the energy of the absorbed neutron exceeds this critical value the compound nucleus oscillates with increasing amplitude until it breaks in two forming t·o separate nuclei. The separation of the nucleus is accompanied with the release of heat, formation of fission products, and the emission of additional neutrons which go on to cause fission of other atoms. In the case of uranium 235 an average of 2.5 neutrons per fission are released. The average value of binding energy released is 200 million electron volts, or mevs, as this quantity of energy is ordinarily called.

The neutrons ejected from the fissioned nuclei invariably have high energies of the order of 1 to 10 mevs. Such neutrons are called fast neutrons. For elements of moderate and high mass numbers there are specific energies for which the rate of a given reaction is exceptionally large. This phenomenon is attributed to what is called "resonance." Neutrons having energies which are close to this resonance value have a much greater probability of a given reaction than do those with higher or lower energies. Uranium, for example, exhibits three marked resonance values for neutrons with energies of 6.5, 21, and 36 electron volts.

In passing through matter, neutrons collide with atomic nuclei of the medium through which they pass, and a transfer of energy from the fast moving neutrons to the slower moving nuclei of the medium takes place. This reduces the energy of the neutron to optimum value of resonance of the fissionable material. Mediums employed to slow the neutrons are called "moderators." Graphite and water are examples.

For a reaction to sustain itself, the number of neutrons produced by fission in each generation must be equal to the number of neutrons absorbed by the fuel and moderator, and neutrons lost through leakage into the surrounding media. The ratio of the neutrons produced to the neutrons absorbed is called the "effective multiplication factor," and is commonly given the symbol "k". If k is equal to one, the number of neutrons produced is equal to the number lost and the reaction is self-sustaining. In this state the system is said to be "critical." If k is less than one the reaction is convergent and dies out and the system is said to be "subcritical." If k is greater than one the reaction is divergent and the system is said to be "super-critical."

The power output of the reactor is directly proportional to the neutron density. Materials such as iron and cadmium have an affinity for neutrons and are commonly used as neutron absorbers to control the ouput of the reaction.

In the design and construction of a swimming-pool reactor we are concerned with six primary factors. These factors are (1) fuel utilized, (2) capacity, (3) moderation of high energy neutrons, (4) reflection to contain neutrons within the core, (5) attentuation of radioactive particles, and (6) cooling. The major components of the device are (1) the reactor core, (2) core carrier and suspension mechanism, (3) pool, and (4) the automatic control system.

Fuel usually employed in the pool reactor is uranium 235, an enriched form of natural uranium 238. The degree of enrichment currently being used in 90% uranium 235 and 10% uranium 238. The fuel is rolled into a thin foil approximately 25 mils thick and 24 inches long. This foil is sandwiched between aluminum cladding 17.5 mils thick on either side of the fuel. The plate is shaped by hot-rolling to a dimension of 60 mils thick. The plates in groups of 18 are then placed in a container fabricated from sheet aluminum and having a hollow journal appended to the bottom. Spacing between the plates is approxmately 100 mils to allow for circulation of pool water through the fuel element. The core of the reactor is built upon a grid plate having some 50 bore holes into which the journals of the fuel element are inserted. The number of elements required in the core depends upon the "critical size." For any combination of fissionable and

*(Please turn to page 42)*

# THE INTELLIGENCE BARRIER

*Reprinted from MOORE SCHOOL RECORD*
*Moore School of Electrical Engineering, Univ. of Pennsylvania*
*Through Courtesy L. A. Rubin*

Over the past years, much time has been spent studying the sound barrier, and now people are investigating the heat barrier. It is the purpose of this highly technical article to start a study of the intelligence barrier.

All the information given below is derived empirically. The phenomenon is well known at The George Washington University, but no doubt it exists in lesser degrees elsewhere. Many classes of undergraduates have felt its effects, and have determined these quantities:

### *THE BARRIER IN GENERAL*

The intelligence barrier is known to exist from wall to wall, floor to ceiling, about half-way between the students and the instructor (see the figure). It also exists as a cylinder around an assistant sitting in the audience. Although absolutely invisible, it obviously exists, and some quantities related to it, such as thickness, density, malfeasance, etc., have been found. It produces indirectly a quantity M between the students.

The intelligence-barrier thickness, T, is computed by the relationship, $T = (D - \cos x)^y$, where D is a minimum thickness, usually about 6.001 inches, and where y is the number of years of teaching experience of the instructor. The solid angle x is measured from a position perpendicular to the blackboard towards the class. Hence the barrier is thickest when the teacher faces the blackboard. Thin barriers tend to pass much hot air.

### *THE ABSORPTION OF INFORMATION*

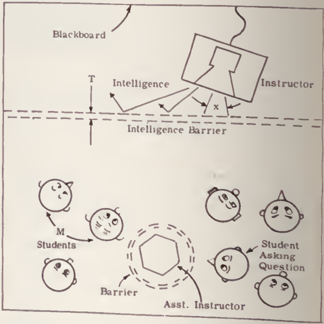
The barrier is unilateral. Information passes from student to instructor readily, but little goes from instructor to students. Hence the absorption from student to instructor, $A_{\text{forward-transfer}}$, equals zero, while the absorption from instructor to students, $A_{\text{reverse-transfer}}$, is equal to $P_bT$, where $P_b$ is the density.

The barrier density, $P_b$, is given by

$$P_b = \int_{\text{start of time}}^{\text{now}} (\Sigma C)\ (m)\ (dt)$$

where $\Sigma C$ is the sum of all known physical constants, m is the malfeasance, and the integration is over all time.

The malfeasance, m, is equal to the quantity $(\infty + j\infty)$. The imaginary component shows that in-




formation is reflected from the barrier surface back to the blackboards. The faculty says this doesn't matter, since the loads (students) are non-absorbant anyway. Of this there is much doubt!

The barrier density, $P_b$, is not to be confused with the instructor density, $P_1$. One of the two quantities is always increasing, like entropy.

When the instructor stands in the front corner of the room, fringing occurs. The formula for absorption must be corrected by adding a term so that the barrier is absolutely impenetrable when the instructor faces the corner. Many instructors take advantage of this, while the rest prefer to stand in front of something they have just written.

A result of the barrier is the formation of a quantity, M, between the students. This is called the mutual pity and it has the dimensions of mere pittances. Needless to say, it is always a maximum.

The figure shows a student questioning the assistant in the audience. Notice his question gets through, but nothing comes back to the student!

Opportunities for study of this phenomenon occur every week-day, and soon much more may be known about the barrier, so that it may be broken.

# OUT OF THE BRIEFCASE

## ELECTRIC WATCH

The Hamilton Watch Company recently announced the development of the world's first electric wrist watch. No larger than a conventional watch, the electric watch offers the highest accuracy and dependability ever achieved and incorporates the first basic change in watch design in almost five centuries.

The radical structure of the electric watch completely eliminates the mainspring. The new watch is the only one in existence which runs without winding or periodic agitation. The watch movement is so exquisitely designed that a tiny energizer the size of a small shirt button will run it for a minimum of twelve months. The electric watch would run for more than 20 years on energy that would operate a 100-watt bulb for no longer than one minute.

The electric watch operates on chemical energy stored in the tiny energizer. This energy is converted into electrical power as it releases a stream of electrons through a coil of fine wire fixed on a balance wheel. The electrical energy through interaction with permanent magnetic fields causes the balance wheel to oscillate. This oscillation is the mechanical energy which runs the watch. The overall result is a precise miniature power plant built into the balance wheel, which in turn powers the gears and moves the hands of the watch. In the past, the balance wheel only controlled the power furnished by a mainspring. The power plant combined with the balance wheel, permits the flow of energy to be strictly controlled and the speed of the hands to be held to an accuracy of more than 99,995 per cent.

The energizer is 400 times more efficient, in terms of space, than the mechanical energy stored in a mainspring, and does an incredible amount of work for its size. In the course of one year it must open and close the circuit 75 million times. The second hand must be pushed forward 75 million times and the balance wheel must oscillate 150 million times.

The electric watch is less complex than the present self-winding type because there is no mainspring or winding mechanism. The result is a simpler and more efficient operation.

## HOT FANS

The Westinghouse Electric Corp. has installed two nine-foot gas recirculating fans, capable of handling gases at 850 degrees F, at an Ohio plant of the American Gas and Electric Service Corp.

For use on the first commercial supercritical pressure steam generator at the plant, the fan wheels must be capable of a top speed of 25,000 feet per minute while handling the hot gases. These wheels begin to glow from the extreme heat when opearting at the high temperatures.

These extreme performance requirements created complex engineering problems in the design of the the fans. It was necessary to control the expansion of the fans, for the wheels, in building up from room temperature to maximum operating conditions will expand $\frac{5}{8}$ of an inch with the other parts of the unit increasing in proportion. Adding to the problem was the fact that the radial-bladed wheels had to be built without side plates. The solution was extra heavy bracing with the housings supported by pedestals holding them clear of the floor, permitting controlled expansion while maintaining necessary clearances. These pedestals are over eight feet tall, and each one weighs over two tons. The fans are 17 feet high over-all and the casings weigh 60,000 pounds.

## IRRADIATED TAPE

Electron bombardment, formerly reserved for the laboratory, is being applied to industry to produce better products. By bombarding a conventional polyethylene tape with high velocity electrons, General Electric has produced a stable, chemical-resistant material for wrapping battery cores. This irradiated tape, trademarked "Irrathene," is used as an insulating material between the battery core and cylinder.

Electron treated tape.

## SUPER - DUPER MAGNETS

Working with invisible iron "dust," General Electric researchers have created a revolutionary and potentially super-strong magnet. The unique properties of this magnet are achieved by precisely controlling the size and shape of individual iron particles so small that there are more than a billion billion in a pound.

Theoretically, the ultra-fine particle iron magnet can be made ten times stronger than the best available

*(Please turn to page 26)*

# What's doing...

Vacuum melting has opened up new horizons for development of alloys. Here, a Pratt & Whitney Aircraft metallurgist is shown as he supervises preparation of an experimental high-strength nickel-base alloy, melted and cast under high vacuum.

Induction melted heat of high-temperature alloy being poured in P & W A's experimental foundry. Molten metal is strained into large water tank, forming metal shot which is remelted and cast into test specimens and experimental parts. Development and evaluation of improved high-temperature alloys for advanced jet engines is one of the challenges facing metallurgists at P & W A.

# at Pratt & Whitney Aircraft in the field of Materials Engineering

The development of more advanced, far more powerful aircraft engines depends to a high degree on the development of new and improved materials and methods of processing them. Such materials and methods, of course, are particularly important in the nuclear field.

At Pratt & Whitney Aircraft, the physical, metallurgical, chemical and mechanical properties of each new material are studied in minute detail, compared with properties of known materials, then carefully analyzed and evaluated according to their potential usefulness in aircraft engine application.

The nuclear physics of reactor materials as well as penetration and effects of radiation on matter are important aspects of the nuclear reactor program now under way at P & W A. Stress analysis by strain gage and X-ray diffraction is another notable phase of investigation.

In the metallurgical field, materials work involves studies of corrosion resistance, high-temperature mechanical and physical properties of metals and alloys, and fabrication techniques.

Mechanical-testing work delves into design and supervision of test equipment to evaluate fatigue, wear, and elevated-temperature strength of materials. It also involves determination of the influence of part design on these properties.

In the field of chemistry, investigations are made of fuels, high-temperature lubricants, elastomeric compounds, electro-chemical and organic coatings. Inorganic substances, too, must be prepared and their properties determined.

While materials engineering assignments, themselves, involve different types of engineering talent, the field is only one of a broadly diversified engineering program at Pratt & Whitney Aircraft. That program — with other far-reaching activities in the fields of mechanical design, aerodynamics, combustion and instrumentation — spells out a gratifying future for many of today's engineering students.

Engineer measures residual stress in a compressor blade non-destructively, using X-ray diffraction. Stress analysis plays important part in developing advanced aircraft engine designs.

The important effects of gases on the properties of metals have been increasingly recognized. Pratt & Whitney chemists are shown setting up apparatus to determine gas content of materials such as titanium alloys.

P & W A engineer uses air jet to vibrate compressor blade at its natural frequency, measuring amplitude with a cathetometer. Similar fatigue tests use electromagnetic excitation.

*World's foremost designer and builder of aircraft engines*

**PRATT & WHITNEY AIRCRAFT**

Division of United Aircraft Corporation

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(Continued from page 23)

magnets. Already experimental magnets have been made equal to the strongest commercial magnets. The new magnet will result in electric instruments that are smaller, lighter, more accurate and more rugged, making possible significant advances in instrumentation. It will help to make better photographic exposure meters, aircraft instruments and other products using permanent magnets .

Ordinary iron is used in the form of sub-microscopic elongated particles to make the new magnet. This leads to another far-reaching benefit, the saving of metals like nickel and cobalt used in making most magnets. The elimination of cobalt makes possible the application of magnets in nuclear reactors, where magnets containing cobalt cannot be used because of the high induced radioactivity.

## WORLD-WIDE T-V

The advent of man-made satellites will make it possible to bring television programs from all over the world into every home, a General Electric rocket expert predicted. The satellites can serve as relay stations in a world-wide television system. The principle is the same as that employed when an airplane recently relayed several live TV programs from Cuba to the U.S. With a satellite, the distances covered could be much greater because of the satellite's height.

A world-wide system could be established with four satellite stations travelling 4,000 miles high over the equatorial section of the earth. The satellites would be equally spaced about the earth and visible at any instant from any point in the earth's equatorial region. A television signal could then be transmitted from any ground location in this region to the nearest satellite and relayed from satellite to satellite. At the proper location, the signal would be retransmitted to a receiving station on earth.

Equipment that the satellites would have to carry for this system would be good quality receivers and transmitters. The major ground equipment required would be a large directional antenna pointed at the satellite.

# ALUMVIEWS

## PRESIDENT'S MESSAGE

*By* FRANK T. MITCHELL
*President, Engineer Alumni Association*

If you were one of the many Engineer Alumni present for the Tompkins Hall Open House held on Saturday, March 9, by the Engineer Alumni Association in cooperation with the faculty, I am sure you join with me in exhibiting an even greater pride in our Alma Mater and its future. The great hospitality shown by Dean Martin A. Mason and his fellow faculty members added to the thrill of seeing for the first time — inside and out — the new home of the School of Engineering.

This visit to Tompkins Hall also brought home to all of us the continuing need to modernize the equipment being used by the present student body. The number of Engineer alumni who are doing what they can to correct this situation through the 1957 Alumni Fund is growing with gratifying results to the sponsoring General and Engineer Alumni Associations. Still more Engineer graduates need to be heard from with contributions large and small to make this year's effort a true success for the School of Engineering.

You have read, of course, the Fund literature and its emphasis on the Tompkins Hall Equipment Fund (to which many non-Engineer alumni are contributing). Now it is our responsibility to justify this top billing by leading the way in contributors and contributions. Don't forget to send in your contribution today!

I am happy to announce that plans for the Howard Lecture, sponsored by the Engineer Alumni Association this year, are being directed by Watson Davis, University Trustee and good friend of the Engineer Alumni Association. We can look forward to an outstanding program through Chairman Davis' leadership.

All Engineer alumni will want to remember the General Alumni Association's Annual Alumni Luncheon which will be held on Saturday, March 23, at 12:30 p.m. in the Willard Hotel. The Engineer Alumni Association always has several tables for alumni and faculty at this outstanding annual event. Call ST. 3-0250, Ext. 305 for reservations.

## ALUMNI NOTES

ROBERT S. BABIN (BEE '47) is Senior Electronic Engineer in the R and D Division of Anderson-Nichols and Co., Boston, Mass. where he designs electronic data processing equipment.

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ROBERT KAMELHOR (BME '49; Sigma Tau) is Chief Engineer at McLean Development Laboratories Inc., designers and manufacturers of air craft armament equipment. He would like to hear from his classmates and promises to reply to any letter received. Address letters to; Robert Kemelhor, 27 Secatogue Lane E. West Islip, N.Y.

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MONROE M. WERNER (BME '50) has been with Kollsman Instrument Co. of Elmhurst, N.Y. since 1951. He is now Assistant Project Engineer in the Navigational Computer Section.

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JOHN W. LEWIS (BCE '51 Theta Tau, Sigma Tau, ASCE) is a Lieutenant in the U.S. Navy Civil Engineering Corps. John is stationed at Yokosuka Navy Base in Japan where he is construction officer.

# CAMPUS NEWS

## THETA TAU

During the Christmas vacation, Theta Tau held its twenty-first biennial convention at Columbus, Ohio, where Sigma chapter was the host. The Gamma Beta representatives were delegate Francis Mikalauskus and alternate Tony Lane.

Prior to the convention, Gamma Beta chapter held their winter beer bust in celebration of the impending final exams for the Fall semester. A few of the Alumni were present at the party, and we are hoping to see many more at the annual Founder's Day Ball and Banquet which will be held at Hunting Towers on March 16.

Theta Tau's contribution to the university intramural program, under the inspired and sometimes coercive leadership of Roy Brooks, has been rewarded with an admirable ranking in the school standings.

## A. S. M. E.

Photonic propulsion, ionic propulsion, and liqud fuel propulsion systems were the subject of Morrow Moore's award winning paper presented before the February meeting of the A.S.M.E. Morrow's paper merited him the John Cannon Award of the George Washington branch and entitles him to compete in national competition with award winners from other A.S.M.E. branches.

Howell Crim and James Peake tied for second place honors with their papers on "Rotary Wing Aircraft" and "Ram Jet Propulsion." Morrow Moore's cash award totaled \$35.00, and the second place winners earned \$15.00 each.

## AIEE - IRE

The last meeting of the joint A.I.E.E. - I.R.E. student branch featured a quick change of pace from the regular meetings. The members were given a thorough excursion through the U.S. Navy logistics computer located here at the university. The electronic giant fully impressed all those present with its digital gyrations.

Several members gained acclaim from the local section in the competition for the annual student awards. John Manning and Earl Reber demonstrated their mastery of Electrical Engineering by winning first and second places in the local student competition from the I.R.E. Joe Greblunas placed first in a similar competition sponsored by the A.I.E.E.

## COUNCIL

Elections to fill positions on the Engineer's Council for the 1957-'58 school year will be conducted on or about April 17. 1957. Elective positions to be filled by this election include two representatives each from the sophomore, junior, and senior classes as well as the graduate school. In addition, one Engineering School Representative to the Student Council will be elected during the University elections to be held in May.

Those students interested in promoting and participating in extracurricular activities are encouraged to seek election to these offices. Application for candidacy should be made on forms available in the Mech-eleciv Office and submitted on or before April 2, 1957.

To be eligible for candidacy, applicants must be registered in the School of Engineering and have a Quality Point Index of not less than 2.0. Candidates for class representatives should have completed the following semester hours of study by the end of this term:

| | |
|---|---|
| Senior: | 106 hours |
| Junior: | 70 hours |
| Sophomore: | 30 hours |

If you do not choose to apply yourself, encourage friends who might be interested to apply.


See what a gentle hint
can get you at
commencement time
TRANSISTOR
Six
RCA VICTOR


**JOHN MORAN,** who joined Western Electric's engineering staff at the Kearny Works recently, is now studying for his M.S.M.E. under the new Tuition Refund Plan. Western Electric expects to refund the tuition for John's graduate study at the Newark College of Engineering this year.

# Western Electric's new TUITION REFUND PLAN can help you continue your studies while launching an exciting career

**Under the new plan,** Western Electric will refund tuition costs for after-hours study at graduate or undergraduate level, up to a maximum of $250 for each school year.

Say, for example, that you decide on a career at Western Electric in one of many rewarding phases of telephony—electronics, development engineering, design, manufacturing production, plant engineering, or some other. You may be eligible for financial assistance to help defray the cost of graduate or other study from the very first day. Choose engineering, science or any course that is appropriate to your job or that adds to your ability to accept greater responsibility, and the Company will refund to you up to $250 a year for tuition. (You'll note from the map on this page that Western Electric's work locations are well situated in terms of major population areas. That means that many of the nation's best schools are close by.)

Plus values, like the new Tuition Refund Plan, give Western Electric engineers many opportunities that others never have. There's specialized training both in the classroom and on the job . . . a formal program of advanced engineering study that includes full-time, off-job courses of up to 10 weeks' duration . . . a retirement and benefit program that's one of the best known and most liberal in industry . . . low-cost life insurance that would appeal to any man with his eye on the future. And of paramount importance is the chance to work alongside top men in the field of communications.

There's a good deal more for which there isn't space here. Why not write us or contact your placement office to schedule an interview when Bell System representatives visit your campus.

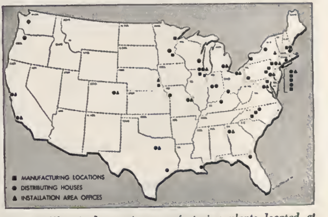
**As one of us,** you'd help engineer the manufacture, distribution or installation of the equipment needed for the nation-wide communications network of 49 million Bell telephones.

Here—where transistors were first developed for production; where repeaters for the new transatlantic telephone cable were tailor-made—there's a constant need for new products and new processes. Two-thirds of the equipment we make today for the Bell telephone companies is of types developed since World War II.

Besides telephone work, Western Electric—over the years — has been responsible for a continuous flow of defense jobs for the government such as the Nike guided missile system and the DEW Line.

There's plenty of room for advancement . . . whatever your field of specialization. So—whether you'd be helping with our telephone job, or working on a major defense project like guided missile systems—with Western Electric you can expect to grow!

For our College Tuition Refund Plan booklet and additional information about Western Electric write: College Relations, Room 1030, Western Electric Company, 195 Broadway, New York 7, N. Y.




*Western Electric has major manufacturing plants located at Chicago, Ill., Kearny, N. J., Baltimore, Md., Indianapolis, Ind., Allentown, Pa., Winston-Salem, N. C., Buffalo, N. Y., North Andover, Mass. Distribution Centers in 30 cities. Installation headquarters in 16 cities. General headquarters: 195 Broadway, New York, N. Y. Also Teletype Corporation, Chicago 14, Illinois*

**Western Electric**

MANUFACTURING AND SUPPLY UNIT OF THE BELL SYSTEM

# SUPERCHARGING

*(Continued from page 15)*

to increase the engine's torque at the low speed where it is needed. Nevertheless, at cruising speeds the centrifugal supercharger can give a horsepower increase of as much as 40 per cent with a torque increase of 22 per cent.

The centrifugal supercharger is light weight and the clearance between the impeller and diffuser does not require close tolerances. In order to achieve a useful pressure rise, the supercharger must be driven at rotational speeds that are 4 to 8 times the engine speed. This fact necessitates the use of high-strength, light-weight alloys in a well-balanced impeller and also creates a lubrication problem which must be carefully considered if the bearings of the supercharger are to be reliable.

The centrifugal supercharger does have a good efficiency over a wide range of pressure boosts, and many of its difficulties have been overcome in such modern superchargers as the McCulloch. The McCulloch supercharger provides the maximum pressure over a wider range by the use of a variable speed drive which embodies a V-belt pulley with a movable flange to change the effective diameter of the pulley and, thus, the speed ratio of the supercharger drive. The flange on the pulley is moved by compressed air acting on a piston, and the admission of air to the piston chamber is controlled by a solenoid which is sensitive to the manifold pressure. This system automatically shifts to low speed when the pressure rise becomes greater than 5 pounds per square inch or the supercharger speed becomes greater than 30,000 revolutions per minute, thereby adding protection to the engine and supercharger as well as maximum pressure over a wider engine speed range.

The McCulloch designers have also given much thought to the bearing problem on their supercharger and are using a special ball-bearing drive with a pressure lubrication system. They claim that the service life of this supercharger is equal to that of the engine on which it would be installed.

Another interesting variation of the centrifugal supercharger is the tubosupercharger which uses the kinetic energy of the engine exhaust gases to drive a turbine connected to the supercharger. This combination has the advantage that no power is taken from the engine other than a small amount lost by the increase of exhaust back pressure. However, this unit requires a turbine and nozzles of high temperature alloys, and still has the disadvantage of direct engine-drive centrifugal superchargers in that pressure rise is very small at low engine speeds.

The Roots superchargers have been used in Europe for many years but have only recently been recognized in the United States. The Roots blower is a positive displacement compressor consisting of a casing enclosing two rotors each with two or more lobes which are helically twisted around the rotor axis. The rotors are geared together so that they mesh without making contact through the lobes. As the rotors turn, the lobes trap a charge of air or mixture between the lobes and the casing and deliver the charge to the outlet side of the super-

*(Please turn to page 34)*

# at Pratt & Whitney Aircraft in the field of Materials Engineering

The development of more advanced, far more powerful aircraft engines depends to a high degree on the development of new and improved materials and methods of processing them. Such materials and methods, of course, are particularly important in the nuclear field.

At Pratt & Whitney Aircraft, the physical, metallurgical, chemical and mechanical properties of each new material are studied in minute detail, compared with properties of known materials, then carefully analyzed and evaluated according to their potential usefulness in aircraft engine application.

The nuclear physics of reactor materials as well as penetration and effects of radiation on matter are important aspects of the nuclear reactor program now under way at P & W A. Stress analysis by strain gage and X-ray diffraction is another notable phase of investigation.

In the metallurgical field, materials work involves studies of corrosion resistance, high-temperature mechanical and physical properties of metals and alloys, and fabrication techniques.

Mechanical-testing work delves into design and supervision of test equipment to evaluate fatigue, wear, and elevated-temperature strength of materials. It also involves determination of the influence of part design on these properties.

In the field of chemistry, investigations are made of fuels, high-temperature lubricants, elastomeric compounds, electro-chemical and organic coatings. Inorganic substances, too, must be prepared and their properties determined.

While materials engineering assignments, themselves, involve different types of engineering talent, the field is only one of a broadly diversified engineering program at Pratt & Whitney Aircraft. That program — with other far-reaching activities in the fields of mechanical design, aerodynamics, combustion and instrumentation — spells out a gratifying future for many of today's engineering students.

Engineer measures residual stress in a compressor blade non-destructively, using X-ray diffraction. Stress analysis plays important part in developing advanced aircraft engine designs.

The important effects of gases on the properties of metals have been increasingly recognized. Pratt & Whitney chemists are shown setting up apparatus to determine gas content of materials such as titanium alloys.

P & W A engineer uses air jet to vibrate compressor blade at its natural frequency, measuring amplitude with a cathetometer. Similar fatigue tests use electromagnetic excitation.

*World's foremost designer and builder of aircraft engines*

**PRATT & WHITNEY AIRCRAFT**

Division of United Aircraft Corporation

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*(Continued from page 32)*

charger. No compression is performed in the Roots blower, and the system depends on the back pressure on the delivery side to compress the fluid. The blower must therefore take in at atmospheric pressure a larger volume of fluid than is displaced by the engine in order to compress the fluid in the manifold.

Theoretically the Roots blower should give a constant pressure boost at all engine speeds, but in practice this does not occur. At low speeds the leakage past the lobes lowers the pressure boost even though the clearance between the lobes and the casing is only 0.004 to 0.008 inches. As the speed increases the pressure boost becomes more nearly constant, but the centrifugal force acting on the impellers tends to elongate the lobes, thereby limiting the speed of the supercharger if rubbing of the lobes on the casing is to be prevented. Unlike the centrifugal supercharger, the Roots blowers is seldom driven more than three times the engine speed and is more often used with a one to one, or one and one-half to one, drive ratio.

The efficiency of the Roots blower is good at lower pressure boosts, but as the pressure is increased, leakage past the rotors reduces the efficiency. The noise of a Roots blower is usually very great unless special insulation and silencers are used to muffle the pulsations of the air flow. One important feature of the Roots blower is that no lubricant is required in the air chamber since none of the parts are in contact in this area. Therefore, the fuel cannot be diluted with oil.

The lack of internal compression of the Roots blower has been remedied in the Lysholm supercharger which is similar to a Roots blower in many respects except for the lobe shape and the flow pattern. The lobes on one rotor are almost all dedendum while the lobes which mesh with them are almost completely addendum. The fluid enters at one end of the supercharger and is trapped in the lobe flanks where it is compressed and moved axially to the delivery end of the supercharger. The advantage of the internal compression is that it raises the adiabatic efficiency of the Lysholm supercharger above that of the Roots, but manufacturing costs are higher for the Lysholm design.

The vane supercharger has been used on several English automobiles and is available in the United States through accessory manufacturers. This supercharger consists of a drum holding movable vanes and mounted so that it rotates eccentrically with respect to the outer casing. When the drum rotates, the vanes are pushed into the drum by the curvature of the casing as they move away from the inlet side. This arrangement results in a positive displacement supercharger with internal compression.

The efficiency of the vane supercharger is higher than that of a Roots blower due to its internal compression. Also the vane compressor is better adapted to high pressure boosts than the Roots. This blower, like the Roots, gives a good pressure boost at low speeds where it is needed for starting and accelerating the automobile.

The movement of the vanes along the casing is the source of trouble in the vane supercharge. If the vanes do not seat well against the casing, leakage will result and will reduce the pressure boost. If the vanes rub the casing, the friction losses in the superchager increase, and the wear on the vanes reduces the allowable speed and the life of the supercharger. Proper lubrication of the vanes is difficult, and often the lubricant is pumped into the engine, diluting the fuel, promoting detonation, and increasing oil consumption. In order to keep the friction losses low and reduce lubrication difficulties, vane superchargers are usually driven at speeds equal to or less than the engine speed. However, this problem may be reduced with improved bearing and vane materials which are being developed.

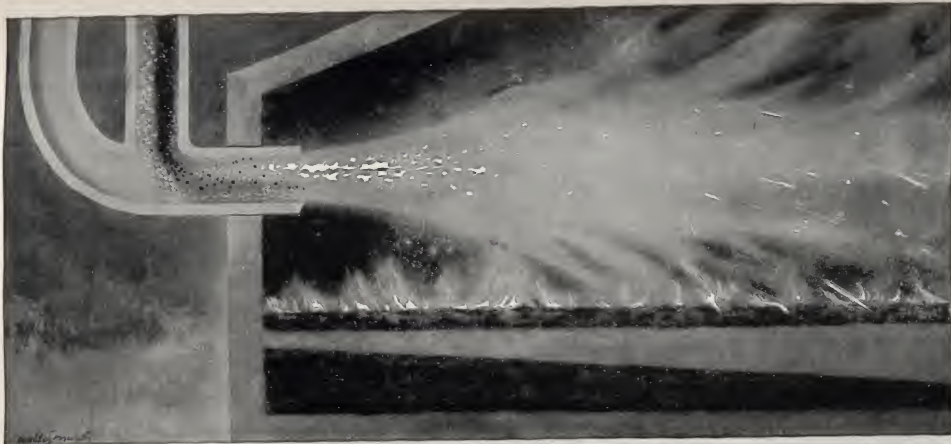
From the foregoing description it can be seen that there are fairly large differences in the characteristics of the three main classes of superchargers. They all have some particular automotive application for which they are well suited as well as limitations to their use under all circumstances. None of the designs give completely satisfactory service in any given situation, but there is still opportunity to develop improved versions of the various supercharger models.

The basis of supercharging for automobile engines is sound. Past experience has shown that supercharging does reduce engine weight per horsepower and engine wear, improve the torque and horsepower characteristics of the engine, and give better mixing of the fuel and air—all with the use of a small amount of engine power and extra fuel.

The rather limited use of superchargers on automobiles today is mainly an economic problem. The cost of a reliable supercharger is high because of the complexity and low production volume of most models and the costly machining that some designs require. In contrast, increasing the power of an engine by enlarging its displacement is a relatively inexpensive process that is freely indulged in by the automobile manufacturers. If the cost of building larger engines or the weight of these engines should ever become impractical, supercharging would become more feasible.

The recent developments in supercharging show much improvement over the models used in the thirties, indicating that supercharger design is keeping abreast of the automobile industry. For instance, such developments as variable speed and turbine drives for centrifugal superchargers and modifications of the Roots design like the Lysholm supercharger show a potentially better adaptability to automobile engines than the direct drive model used on Grahams or the noisy Roots blower used on the SS Mercedes.

A tendency toward wider use of superchargers may be indicated by the installation of McCulloch superchargers on the 1957 Packard and Studebaker Golden Hawks, but even if this trend does not materialize, superchargers will undoubtedly be employed to some extent as long as reciprocating gasoline engines are used on automobiles.



An artist's inside look at 1000-ton-a-day oxygen flash smelting furnace of Inco-Canada at Copper Cliff, Canada.

# INFORMATION STORAGE

*(Continued from page 19)*

force and polarization in the direction thereof, similar to the hysteresis loop exhibited by ferromagnetic materials. This "electrostatic hysteresis" is characteristic of piezoelectric substances such as barium titanate, Rochelle salt, potassium dihydrogen phosphate, sodium niobate.

Crystals of these compounds vary among themselves with respect to the temperature range within which they exhibit ferroelectric properties, and in coercivity, dielectric constant and saturation polarization. Of these materials, barium titanate is particularly suitable as a ferroelectric memory element.

Among the advantages of the ferroelectric memory elements as compared with the ferromagnetic memory elements are: (a) no eddy current losses; (b) no magnetic domains to reverse, with significant power required; (c) a frequency range extending to megacycles. There are, of course, electrostatic domains in barium titanate, but their reversal has been accomplished with voltage pulses as short as one-half microsecond.

The characteristics of compactness, wide frequency range of operation, simplicity and low power consumption make the ferroelectrics especially useful for binary storage circuits and particularly in digital computers and switching systems.

When barium titanate is used under conditions providing a substantially rectangular hysteresis loop, a two-dimensional binary storage system is evolved. A number of groups of binary digits may be stored in this system at one time. Any stored group of digits may then be read out of the system without disturbing other stored groups. The storing and reading-out of groups of digits may be at either random or uniform time intervals. By employing an array of parallel line electrodes on opposite faces of a single ferroelectric crystal or sheet of ceramic, as many as 2,500 binary digits may be stored in a space one inch square by a few thousands of an inch thick.

The ferroelectrics as memory elements, are now coming into popular use in industry.

MAGNETIC CORES

A magnetic binary core in a magnetic binary circuit is capable of being magnetized to saturation in either of two directions. Magnetic material having the property of low coercive force and high residual magnetism may be readily magnetized in one direction or one remanence state representative of a binary "one" and in the opposite state representative of a binary "zero." A core fabricated of such materials may be placed in one of these two states of remanence by means of windings on the core to which pulses are applied, and the particular state existing within a core may be determined by a voltage pulse induced in other windings, on the core when the flux state is reversed. An ideal core material for this purpose would have a substantially rectangular hysteresis loop, such as that illustrated in the figue.

With the binary "zero" state arbitrarily selected as point "a" on the curve, application of a positive magnetizing force H sufficiently greater than the coercive force $+H^1$ will cause the core to traverse the hysteresis

*(Please turn to page 40)*

loop to saturation point "b", and, on removal of the applied magnetomotive force, return to point "c" which represents a binary "one" state. Similarly, when in a "one" remanence state, application of a negative magnetizing force H sufficiently greater than the coercive force $-H^1$ causes the core to traverse its hysteresis loop from point "c" to point "a" and, on removal, to point "a". The change in flux when the core is caused to go from the "one" state to the "zero" state or from the "zero" state to the "one" state, induces an output voltage pulse in each of the windings on the core; however, application of a magnetomotive force tending to maintain the core in either existing remanence state would ideally produce no flux change and, consequentially, no output pulse would appear. Due to the fact that core materials do not possess perfectly rectangular hysteresis loops, there is a flux change. This may occur during application of a read-out pulse as the core switches from its stable negative remanence state "a" to its negative saturation state "d" a voltage of reduced magnitude is induced in the secondary windings. Provision is made, therefore, for discriminating between output pulses produced on reading out from a "zero" remanence state and on reading out from a "one" remanence state.

By using a plurality of cores and when placed in the proper circuits, magnetic cores can be utilized to store a vast amount of binary information. No power is required to maintain a core in a particular state and only small amounts of power are required for reading or switching. One of the most attractive features of magnetic core storage is the fast access time which may be of the order of a microsecond.

Countless devices can and are used for the storage of information. The main factors involved in selection of the best storage devices are power requirements and access time. Until recently Electronic Data Processing Machines (EDPM) used flip-flops in the shift registers (for transient storage) and magnetic drums for information stored for longer periods of time; however, because of the low power drain and lightning fast access time of ferro-electrics and magnetic cores, these devices have become extremely popular in present day EDPM.

*(The circuits shown in this article are covered by U.S. Patents.)*

# REACTORS

*(Continued from page 21)*

moderating material there will be a lower limit to the size of workable unit owing to leakage losses. This lower limit has been given the name "critical size."

Ordinary water circulating through the elements serves as a moderator, coolant, and reflector. Water of the pool is circulated by free convection upward through the hollow journal passing through the spacing between the fuel plates and out into the pool. Under conditions of normal operation the temperature rise in the core is about 22 degrees Fahrenheit. The heat capacity of the pool is such that the temperature rise of the pool water is about one half a degree Fahrenheit per hour.

Reflectors or blankets are employed in reactors to contain the neutrons emitted by fission of the fuel and to reduce the loss of neutrons by leakage into the surrounding media. A good reflector will reduce the fuel requirement for critical loading and improve the neutron flux distribution within the core. In the pool reactor the reflector ordinarily consists of the pool water. Dummy elements loaded with graphite, or beryllium-oxide, may be placed around the fuel elements to increase the effective reflection of neutrons. The employment of these reflectors instead of water reduces the critical load from 3.5 kilograms to 2.5 kilograms.

Shielding is required for nuclear reactors to protect operating personnel from the effects of radioactive particles and to prevent radioactive interference with satisfactory functioning of instruments employed in the operation of the reactor. Particles of primary concern are gamma rays, fast neutrons and thermal neutrons. In the pool reactor the core is usually situated below ground level so that shielding in the horizontal direction and vertically down is infinite. Above the core 17 feet of water will attentuate gamma rays to the extent that a person standing next to the pool will receive less than the maximum allowable exposure of 60 milliroetgens in eight hours. Ten feet of water between the core and walls of the pool has been found adequate to prevent the concrete from becoming activated or damaged from absorption of radioactive particles.

The grid plate mounting the core is suspended in the pool by means of a hanger fabricated from aluminum beams transversely braced, extending upward to a bridge spanning the width of the pool and portably mounted on tracks traversing the length of the pool. The reactor can thus be located at any point along the center line of the pool.

The pool is constructed of reinforced concrete. A gate is provided at one end of the pool to permit the reactor to be withdrawn into an isolation chamber for purposes of draining the pool.

The power output of the reactor is directly proportional to the neutron density. To control the neutron desity, control rods of stainless steel having an affinity for neutrons are inserted into the core. The depth at which the rod is inserted into the core controls the number of neutrons absorbed by the rod. A connecting link is fastened to one end of the control rod and the other end of the link is fastened to an iron armature. The armature and rod are lifted by an electro-magnet whose exciting current is controlled by a servo-mechanism. The control rod can then be adjusted to maintain the desired output. Two and sometimes three safety rods are placed at the top of the core. These safety rods are usually made of cadmium which absorbs neutrons at a high rate. In event of malfunction of the reactor sudden temperature rises in the core will activate a temperature control which releases the cadmium rods and drops them into the core. The cadmium absorbs neutrons at a faster rate than the rate produced by fission and the system converges and dies out.

The research reactor is playing an important part in the development of nuclear energy in providing a means to secure much needed experimental data. Studies being made with the reactor include typical critical loadings, control rod effectiveness and calibration, effects of temperature rise on nuclear reactions, flux measurements of neutrons and radioactive particles, and effects of radiation on materials and biological substances.



An engineer taking a course in biology was asked on an examination to name three kinds of sheep. He astounded his professor by answering," Black sheep, white sheep, and hydraulic ram."

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Sweet Young Coed: "Stop! Stop! Where is your chivalry?"

M.E.: "I traded it in for a Ford. Let's neck."

# HEADACHE CORNER

*Sy Matthew B. S. E. '57*

Are you engineering studies becoming too great a burden? Do you find that you can't sleep at night because you worry about that problem in dynamics that you can't work? Then relax. Drive the worries from your mind. Take up your pencil. feel the tension ease and sense a greater confidence and ability as you solve the following problems with proficiency.

Find three integers, X, Y, and Z, all different, such that the following equation will be satisfied:

$$(X-1)^5 - (Y-1)^3 = (Z-1)^2 - 1$$

< • >

At twelve noon on March 1, 1956 Anthony McFursten bought a clock which had some peculiar properties. The clock not only told the time of day but also the date. Each hour of the day the clock gained five minutes if Anthony had put the cat out the night before. If Anthony forgot to put the cat out, the clock lost one minute per hour during the following day. During each day when Anthony did not let the cat in, the clock gained three minutes per hour. Each day that Anthony missed eating breakfast, the clock stopped for one hour. Every Friday and on the 30th day of each month, Anthony forgot to let the cat out at night. He did not let the cat in the house on April Fools' Day. He let the cat out at night and let it in the next morning on all other days. Anthony missed breakfast every Monday and on April Fools' Day. When Anthony bought the clock, it told the correct time. What was the reading of the date and the time of day on the clock at noon on March 1 , 1957?


A farmer wishes to plant ten rows of apple trees in his orchard with only nineteen trees. What is the maximum of trees he can plant in each row if each row is to have the same number of trees? How should the trees be oriented?
Explain how such an occurence could happen.

< • >

A college professor walked into his classroom on the first day of class and found that 60 students had registered for the course and that all were present. The college had a definite rule that no more than 30 students could be allowed to stay in his class. Due to a mistake at the time of registration 30 students too many were allowed to register for his course and there was no way of finding which students were the last to register. It was left up to the professor to decide which 30 students must be eliminated from the course. Being a math professor and having his prejudices, but not willing to embarrass any student, he decided to eliminate students, who had given him great troubles in previous courses, by means of a trick. He asked the class if they would agree to let him arrange them in a circle. start with one student and eliminate every ninth person until only thirty were left. The students remaining in the circle would stay in the course. Subsequently, the student of his choice were the ones who made up the class. How were the students placed in the circle and where did the counting start? What is the general rule for solving such a problem?

< • >

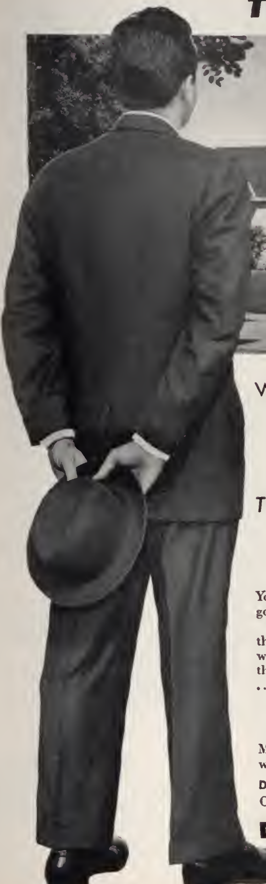
Mr. Fly, who lost his wings in a fight with another fly (I believe the fight was due to a misunderstanding concerning a Miss Fly), was standing in the corner of a room 20 ft. long, 9 ft. high, and 14 ft. deep. Feeling that he would be more comfortable in his home at the diagonal corner of the room, he decided to go home and nurse his wounds. Wingless and weak from the loss of blood, he proceeded to walk home by the shortest route. How far did he walk and which paths could he have taken?

< • >

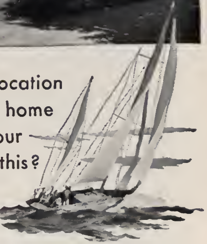
If a stone is placed in a bucket of water, how can the stone cause a displacement of water such that the volume of water displaced is greater than the volume of the stone? How can the stone cause a displacement of water such that the volume of water displaced is less than the volume of the stone?

Relax for a few hours while solving the preceding problems. After you obtain correct answers for all of them, go back and try your dynamics problem again. It will seem easy. Send your answers to the above problems to *Mechelecív*. The person who supplies the greatest number of correct answers will receive recognition in a later issue.

# ENGINEERS...LOOK TEN YEARS AHEAD!



A Douglas engineer lives here



## Will your income and location allow you to live in a home like this...spend your leisure time like this?

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# MECH-MISS
# FOR
# MARCH

Stand aside Messrs. Stefan and Boltzman, because Lloydell Jones has come up with some entirely new data on the ideal black-body. Actually there has been some question raised by the more thorough observers whether or not Kirchoff's Law would hold for this very *special* case.

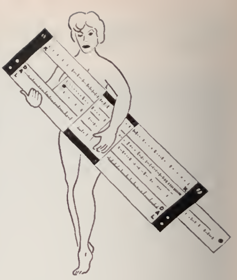
Since all scientific experimentation is expected to yield some meaningful physical constants, we are sure everyone will be delighted with some extremely significant constants.

$$[5.87]^2 — [4.95]^2 — [5.93]^2$$

Where the dimensions are of course, inches to the one half power.

Lloydell, a Speech major hailing from Omaha, and a member of Kappa Kappa Gamma Sorority, has another kinship with the School of Engineering. As Theta Tau's candidate for the Apple Blossom Queen she was selected as one of the University Princesses. This is a natural conclusion based on the observed data and the sizable coefficient of charm.

# SLIPSTICK



### A FAIRY TALE FOR ENGINEERS

Once upon a time there was a cute little doll by the name of Little Red Riding Hood. This cutie was the most . . . to say the least. When this babe was kinetic, the males were energetic, for there was nothing synthetic.

Red had a job in a consulting firm filling out forms. She soon became a specialist, and when it came to filling out forms, she was given credit for many a raise.

One day while Red was on her way to work, she was met by a shaggy character obviously a wolf. "Go away wolf," said Red.

"Wolf!" said the wolf. "Who are you calling a wolf. I am an engineer."

"If you're an engineer, why do you have that silly grin." asked Red.

"Did you ever see an engineer without a sly drool?" replied the wolf.

Red was obviously a naive kid, she believed him, for indeed she had never seen an engineer without a sly drool.

"Let's go for a paddle on the lake," suggested the wolf, "and I will sing you songs."

"Are you hep, man, I mean really hep?" said Red.

"Well," said the wolf, "I know some logarithms and some numbers by Reynolds and Mach."

"Thermal!" said Red, "Let's off for the pond."

And so they went hand and hand for the pond. They crossed the Wheatstone bridge and went down to the dock. "Canoe swim?" asked Red.

"No!" replied the wolf (wolves are notoriously poor swimmers) as he clambered into the canoe with his uke. The wolf had hardly begun to penetrate the sound barrier when Red noticed the wolf's tail.

"What's this tale about you being an engineer. Explain that tail," said Red. "Any wolf that thinks I'm a misguided miss'll get his." shouted Red. There upon she whipped out a pair of manacles, clamped them on the wolf's paws and tossed him into the drink.

The wolf, being a resourceful type took a file out of his pocket, cut through the chains and crawled along the bottom toward home. Once on the bank, the wolf hightailed it for his cave. When he got to his cave he hurriedly sat down on a trap some darn fool had left about, thus ending the tail.

MORAL: Both engineers and wolves need files.

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Engineer on telephone: "Doctor. come quick! My little boy just swallowed my slide rule."

Doctor: "Good Heavens man I'll be right over. What are you doing in the meantime?"

Engineer: "Using log tables."

**"In the future Mr. Lane, you will not tie your ground wire to the metal stools!**

Noah was standing at the gangplank of the ark giving instructions to the pairs of animals as they left. When two adders came along he said, "Go forth and multiply."

"But we're adders and don't know how to multiply," they replied.

"Then go forth and seek the mysteries of multiplication," Noah instructed.

After the last pair of animals had left the ark, Noah and his family ventured forth unto the land. Sometime later he stumbled over a pile of logs and on looking down discovered the pair of adders and several little adders secluded among the logs. "I see that you have discovered the secret of multiplication."

"Yes," hissed one of the snakes. "we found that it's easy for us adders to multiply by logs."

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The day after finals a disheveled M.E. walked into a psychiatrist's office. tore open a cigarette, and stuffed the tobacco up his nose.

"I see you need some help," said the startled doctor.

"Yeah," agreed the M.E., "Got a match?"

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"You can't beat the system," moaned a student after looking at his semester grades. "I took a course in basket weaving for a snap elective and then two Navahoes enrolled and raised the curve so that I flunked."


Illustration shows test of aircraft compass at United States Gauge, division of American Machine and Metals, Inc. A magnetic force, developed by the loops, pulls the compass card 30° off its normal heading. Then the force is released. The instant of release and the moment the compass recovers by 5° are both recorded on the film—become positive evidence of proper performance.

# Wanted: an inspector with a split-second eye —*photography got the job*

**A difference of 2/10ths of a second means the compass passes or fails. So the maker pits it against a stop watch—gets definite proof of performance with movies.**

Uncle Sam said this aircraft compass must respond by 5 degrees in not less than 1 second or more than 1.2 seconds. That's only 2/10ths of a second leeway—far too little for human hands and eyes to catch the action accurately.

So, side-by-side, the stop watch and compass act their parts before the movie camera. Then individual frames along the film show the precise instant that the 5-degree mark is reached.

Product testing and quality control are naturals for photography. They are typical examples of the many ways photography works for businesses, large and small. It is improving production, saving time, reducing error, cutting costs.

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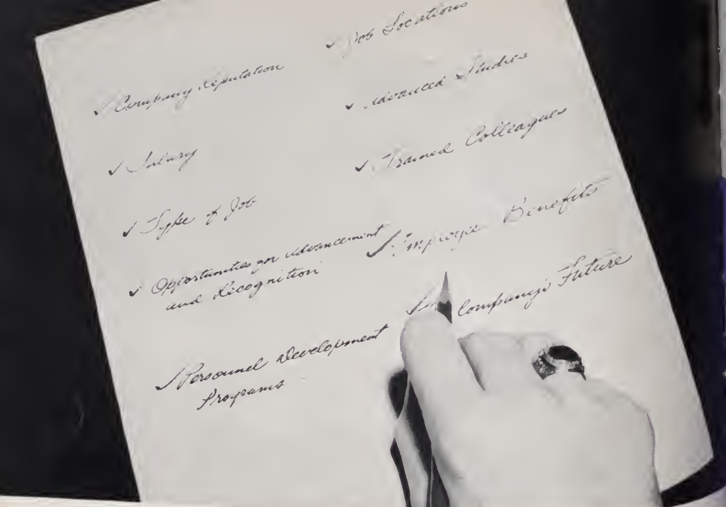

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